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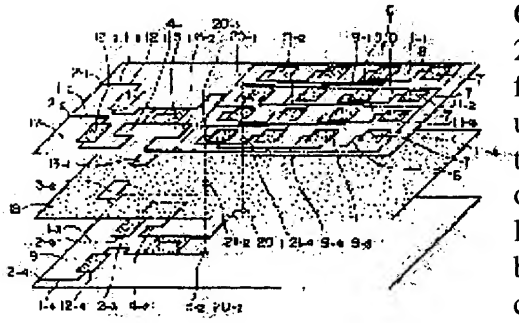
(54) ARRAY ANTENNA AND FEEDING METHOD TO SAME



(57)Abstract:

PURPOSE: To realize an array antenna at a low cost because of easy manufacturing in which the freedom of arrangement of antenna elements is high, and a feeding method to the array antenna.

CONSTITUTION: A 1st circuit network and a 2nd circuit network forming a Batler matrix feeding circuit are formed respectively onto an upper side board 17 and a lower side board 19 in the array antenna C composed of a microstrip line on the surfaces of the upper side board 17 and the lower side board 19 having a ground board 18 in between, and the 1st circuit network and the 2nd circuit network are intercoupled electromagnetically by slot coupling hybrid circuits 12-1 to 12-4. Furthermore, microstrip arrays 11-1 to 11-4 are formed on the upper side board 17, and the 1st circuit network supplies a high frequency signal to the microstrip arrays 11-2, 11-4 and the 2nd circuit network supplies a high frequency signal to the microstrip arrays 11-1, 11-3.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is array antennas which supply electric power to two or more antenna elements in a RF signal, and relates to the electric supply method to the array antennas and array antennas especially using the Butler matrix feeder circuit.
[0002]
[Description of the Prior Art] Drawing 10 is the perspective diagram showing the example of composition of the micro-stripe antenna equipped with the conventional Butler matrix feeder circuit. In drawing 10 , 10 is the double-sided substrate which used dielectrics, such as a fluororesin and an alumina. Each part of drawing is formed of microstrip lines, such as copper foil, on the upper surface of this double-sided substrate, and copper foil etc. is stuck on the front face on the inferior surface of tongue which is not visible in this drawing. 1-1 to 1-4 is a microstrip line by which electric power is supplied to a RF signal from the electric supply terminal 2-1 to 2-4, respectively. As for a branch line type hybrid circuit, 4-1, 4-2 and 6-1, and 6-2, 3-1 and 3-2 are [the delay line, 5-1, and 5-2] air bridges (air wiring).
[0003] 11-1 to 11-4 is a micro-stripe array, and a RF signal is inputted through the electric supply line 9-1 to 9-4, respectively. the electric supply lines 8 and 8 of further plurality [signal / RF / this] -- each antenna elements 7 and 7 which were distributed to ... and connected to these -- it emanates from ... each electric supply lines 8 and 8 shown in this drawing -- if it is in ..., it branches to two electric supply lines 8 and 8, respectively from each electric supply line 9-1 to 9-4, and each of this electric supply line 8 has composition (such composition is called tournament composition after this) which branches to two more electric supply lines 8 and 8
[0004]
[Problem(s) to be Solved by the Invention] This drawing 10 shows the example of the array antennas A by 4 port flat-surfaces monolayer structure Butler matrix feeder circuit which used only the branch line type hybrid circuit. As shown in this drawing, when the Butler matrix feeder circuit is formed only using a branch line type hybrid circuit, the portion (the air bridge 5-1, 5-2) which a transmission line intersects must be formed. Then, the air bridge formed except a microstrip line had to be used like the example shown in this drawing, and it could not but correspond with wiring of VIA (through hole) or a semi rigid cable etc.
[0005] Moreover, in the case of the array antennas using the Butler matrix feeder circuit, a radiation beam scanning angle is determined by the interval of each antenna element. However, when the above tournament composition was formed, the problem that the

flexibility of the number of antenna elements will be restricted arose.
[0006] On the other hand, drawing 11 is the perspective diagram showing another example of composition of the antenna using the conventional Butler matrix feeder circuit. The Butler matrix feeder circuit B shown in this drawing consists of an upper surface substrate 17 of a dielectric, same inferior-surface-of-tongue substrate 19, and grand boards 18, such as a copper plate inserted in during this period. These are made to rival on both sides of a dielectric in the meantime, and each part is formed in the upper surface of the upper surface substrate 17, and the inferior surface of tongue of the inferior-surface-of-tongue substrate 19 of microstrip lines, such as copper foil, respectively.
[0007] In drawing 11 , the slot coupling type hybrid circuit by which 12-1 and 12-2 were formed in the 17th page of an upper surface substrate, 12-3, and 12-4 are the slot coupling type hybrid circuits formed in the 19th page of an inferior-surface-of-tongue substrate. This slot coupling type hybrid circuit 12-1 and 12-3 are combined through the slot (aperture) 13-1 formed in the grand board 18, and the slot coupling type hybrid circuit 12-2 and 12-4 are combined through the slot 13-2 formed in the grand board 18. Moreover, for 36-1 and 36-2, as for an output terminal and 16-1 to 16-4, a transmission line and 14-1 to 14-4 are [an antenna element and 15-1 to 15-4] feeders.
[0008] This drawing shows the composition of the antenna feeder circuit B by 4 port flat-surfaces two-layer structure Butler matrix feeder circuit without intersection of the conventional line. By using combining a branch line type hybrid circuit and a slot coupling type hybrid circuit, this composition realizes composition without intersection of a line. However, the feeder which connects the Butler matrix feeder circuit and an antenna element not only crosses, but this composition has the fault that each antenna element cannot be arranged in the same side. It was made under the above backgrounds, this invention has the high flexibility at the time of arranging an antenna element, and since manufacture is easy, it aims at cost offering the electric supply method to low array antennas and array antennas.
[0009]
[Means for Solving the Problem] If it is in invention according to claim 1 in order to solve the technical problem mentioned above In the feeder circuit which has two or more input/output terminals which sandwich a common grand board, and by which by halves of a feeder circuit has been arranged at the both sides, and the array antennas which consist of two or more radiating elements It connects-like. the output terminal and radiating element of the aforementioned feeder circuit which the aforementioned grand board exists to the position where the radiating element has been arranged, and exist in the same field as the aforementioned radiating element -- a microstrip line -- direct or electromagnetism -- with the aforementioned radiating element the slot formed in the through hole or the aforementioned grand board with the output terminal of the aforementioned feeder circuit which exists in plane of symmetry on both sides of the aforementioned grand board -- minding -- electromagnetism -- it is characterized by connecting-like
[0010] moreover -- if it is in invention according to claim 2 -- a conductor -- with the grand board which consists of boards They are the array antennas which consist of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or

the 2nd dielectric board. The Butler matrix feeder circuit into which it consists of the 1st network formed in the front face of the 1st dielectric of the above, and the 2nd network formed in the front face of the 2nd dielectric of the above, and two or more RF signals are inputted, it constitutes from a slot formed in the aforementioned grand board -- having -- the 1st network of the above, and the 2nd network of the above -- electromagnetism -- with the 1st coupling means combined-like The 1st radiation means which it is formed in the front face of the 1st dielectric of the above, and a RF signal is supplied from the 1st network of the above, and is emitted, The 2nd radiation means which it is formed in the front face of the 1st dielectric of the above, and a RF signal is supplied from the 2nd network of the above, and is emitted, The 2nd coupling means which combine the 2nd network of the above, and the radiation means of the above 2nd, It is prepared in either [at least] the above 1st or the 2nd network, and is characterized by providing one which adjusts the phase of the RF signal supplied to the above 1st or the 2nd radiation means, or two or more phase adjustment meanses.

[0011] Moreover, if it is in invention according to claim 3, in array antennas according to claim 2, the 2nd coupling means of the above are formed between the front face of the dielectric board of the above 1st, and the front face of the dielectric board of the above 2nd, and are characterized by being the through hole which does not have combination between the aforementioned grand boards.

[0012] moreover, if it is in invention according to claim 4, the 2nd coupling means of the above are formed in the aforementioned grand board in array antennas according to claim 2 -- having -- the 2nd network of the above, and the radiation means of the above 2nd -- electromagnetism -- it is characterized by consisting of slots combined-like

[0013] Moreover, if it is in invention according to claim 5, in array antennas according to claim 2, it is characterized by constituting the Butler matrix feeder circuit by the 1st network of the above, and the 2nd network of the above. Moreover, if it is in invention according to claim 6, in a claim 3 or array antennas according to claim 4, the above 1st or the 2nd radiation means is characterized by consisting of FLs which distribute the aforementioned RF signal to two or more antenna elements and two or more aforementioned antenna elements.

[0014] Moreover, if it is in invention according to claim 7, in a claim 3 or array antennas according to claim 4, the FL which the above 1st or the 2nd radiation means consists of FLs which distribute the aforementioned RF signal to two or more antenna elements and two or more aforementioned antenna elements, and constitutes the radiation means of the above 1st, and the FL which constitutes the radiation means of the above 2nd are characterized by being formed in a mutually different field.

[0015] Moreover, it is characterized by consisting of two or more connection lines the above 1st or the 2nd radiation means connects [connection / invention] between two or more antenna elements and two or more aforementioned antenna elements one by one with a claim 3 or array antennas according to claim 4 if it is in invention according to claim 8.

[0016] moreover -- if it is in invention according to claim 9 -- a conductor -- with the grand board which consists of boards They are the array antennas which consist of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or the 2nd dielectric board. The Butler matrix feeder circuit into which it consists of the 1st

network formed in the front face of the 1st dielectric of the above, and the 2nd network formed in the front face of the 2nd dielectric of the above, and two or more RF signals are inputted, it constitutes from a slot formed in the aforementioned grand board -- having -- the 1st network of the above, and the 2nd network of the above -- electromagnetism -- with the 1st coupling means combined-like The 3rd dielectric prepared in the part on the front face of the 1st dielectric of the above, and the 1st radiation means which it is formed in the front face of the 3rd dielectric of the above, and a RF signal is supplied from the 1st network of the above, and is emitted, The 2nd radiation means which it is formed in the front face of the 3rd dielectric of the above, and a RF signal is supplied from the 2nd network of the above, and is emitted, The 2nd coupling means which combine the 2nd network of the above, and the radiation means of the above 2nd, The 3rd coupling means which combine the 1st network of the above, and the radiation means of the above 1st, It is prepared in either [at least] the above 1st or the 2nd network, and is characterized by providing one which adjusts the phase of the RF signal supplied to the above 1st or the 2nd radiation means, or two or more phase adjustment meanses.

[0017] Moreover, if it is in invention according to claim 10, in array antennas according to claim 9, the above 2nd or the 3rd coupling means is formed between the front face of the dielectric board of the above 1st, and the front face of the dielectric board of the above 2nd, and is characterized by being the through hole which does not have combination between the aforementioned grand boards.

[0018] moreover, if it is in invention according to claim 11, in array antennas according to claim 9, the above 2nd or the 3rd coupling means is formed in the aforementioned grand board, and combines the 2nd network of the above, and the radiation means of the above 2nd -- making -- or the 1st network of the above and the radiation means of the above 1st -- electromagnetism -- it is characterized by consisting of slots combined-like

[0019] moreover -- if it is in invention according to claim 12 -- a conductor -- with the grand board which consists of boards It is the electric supply method to the array antennas which supply electric power to the array antennas which consist of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or the 2nd dielectric board in a RF signal. The 1st network formed in the front face of the 1st dielectric of the above, and the 2nd network formed in the front face of the 2nd dielectric of the above, Two or more RF signals are inputted by the Butler matrix feeder circuit which consists of the 1st coupling means combined-like. the 1st dielectric of the above, and the 2nd dielectric of the above -- electromagnetism -- A RF signal is supplied and emitted to the 1st radiation means formed in the front face of the 1st dielectric of the above from the 1st network of the above. A RF signal is supplied and emitted to the 2nd radiation means formed in the front face of the 1st dielectric of the above from the 2nd network of the above, and it is characterized by preparing the 2nd coupling means between the 2nd network of the above, and the radiation means of the above 2nd.

[0020] Moreover, if it is in invention according to claim 13, by the electric supply method to array antennas according to claim 12, it is formed at the 2nd coupling means of the above between the front face of the dielectric board of the above 1st, and the front face of the dielectric board of the above 2nd, and is characterized by using the through hole which does not have combination between the aforementioned grand boards.

[0021] moreover, if it is in invention according to claim 14, by the electric supply method to array antennas according to claim 12, it forms in the 2nd coupling means of the above at the aforementioned grand board -- having -- the 2nd network of the above, and the radiation means of the above 2nd -- electromagnetism -- it is characterized by using the slot combined-like

[0022] moreover -- if it is in invention according to claim 15 -- a conductor -- with the grand board which consists of boards It is the electric supply method to the array antennas which supply electric power to the array antennas which consist of microstrip lines constituted from copper foil etc. by the front face of the 1st and 2nd dielectric boards which sandwich the aforementioned grand board, and the above 1st or the 2nd dielectric board in a RF signal. The 1st network formed in the front face of the 1st dielectric of the above, and the 2nd network formed in the front face of the 2nd dielectric of the above, Two or more RF signals are inputted by the Butler matrix feeder circuit which consists of the 1st coupling means combined-like. the 1st dielectric of the above, and the 2nd dielectric of the above -- electromagnetism -- For the 1st radiation means on the front face of the 1st dielectric of the above which prepared the 3rd dielectric in part and was formed in the front face of the 3rd dielectric of the above For the 2nd radiation means which supplied and emitted the RF signal from the 1st network of the above, and was formed in the front face of the 3rd dielectric of the above It is characterized by supplying and emitting a RF signal from the 2nd network of the above, preparing the 2nd coupling means between the 2nd network of the above, and the radiation means of the above 2nd, and preparing the 3rd coupling means between the 1st network of the above, and the radiation means of the above 1st.

[0023] Moreover, if it is in invention according to claim 16, by the electric supply method to array antennas according to claim 15, it is formed at the above 2nd or the 3rd coupling means between the front face of the dielectric board of the above 1st, and the front face of the dielectric board of the above 2nd, and is characterized by using the through hole which does not have combination between the aforementioned grand boards.

[0024] moreover, if it is in invention according to claim 17, by the electric supply method to array antennas according to claim 15, it forms in the above 2nd or the 3rd coupling means at the aforementioned grand board -- having -- the 2nd network of the above, and the radiation means of the above 2nd -- electromagnetism -- it joins together-like -- making -- or the 1st network of the above and the radiation means of the above 1st -- electromagnetism -- it is characterized by using the slot combined-like

[0025]

[Function] In the array antennas which are constituted by the front face of the 1st which sandwiches a grand board, and 2nd dielectric boards by the microstrip line according to this invention the 2nd network which forms in the front face of the 1st dielectric the 1st network which constitutes the Butler matrix feeder circuit, and constitutes the Butler matrix feeder circuit -- the front face of the 2nd dielectric board -- forming -- between the 1st network and the 2nd network -- the 1st coupling means -- electromagnetism -- it is made to join together-like Moreover, the 1st radiation means and the 2nd radiation means are formed in a 1st dielectric side, a RF signal is supplied to the 1st radiation means from the 1st network, and a RF signal is supplied to the 2nd radiation means from the 2nd network. A RF signal is supplied to the 2nd radiation means by the microstrip line, the

2nd, or 3rd coupling means from the this 1st network to 1st radiation means, and 2nd networks.
[0026]
[Example] Below, the example of this invention is explained.
A. The 1st example drawing 1 is the perspective diagram showing the composition of the 1st example of this invention. The array antennas C using 4 port BATORA matrix feeder circuit shown in drawing 1 consist of an upper surface substrate 17 of a dielectric, same inferior-surface-of-tongue substrate 19, and grand boards 18, such as a copper plate inserted in during this period. These are made to rival on both sides of a dielectric in the meantime, and each part is formed in the upper surface of the upper surface substrate 17, and the inferior surface of tongue of the inferior-surface-of-tongue substrate 19 of microstrip lines, such as copper foil, respectively.
[0027] 1-1 to 1-4 is a microstrip line by which electric power is supplied to a RF signal from the electric supply terminal 2-1 to 2-4, respectively. 12-1 and 12-2 are the slot coupling type hybrid circuits formed in the upper surface substrate 17, and a RF signal is inputted through a microstrip line 1-1 or 1-2, respectively. Moreover, 12-3 and 12-4 are the slot coupling type hybrid circuits formed in the inferior-surface-of-tongue substrate 19, and a RF signal is inputted through a microstrip line 1-3 or 1-4, respectively.
[0028] In the grand board 18, the slot 13-1 or the slot 13-2 is formed in the slot coupling type hybrid circuit 12-1 or the portion corresponding to 12-2, respectively. For this reason, it has joined together through the slot 13-1 formed in the grand board 18, and the slot coupling type hybrid circuit 12-1 and 12-3 have combined the slot coupling type hybrid circuit 12-2 and 12-4 through the slot 13-2 formed in the grand board 18. In two micro-stripe transmission lines which are originally divided with a grand board, and ** and are parallel, by forming a slot (aperture) in a grand board in the meantime, a slot coupling type hybrid circuit constitutes a directional coupler (hybrid circuit), and a RF signal is compounded effectively or it branches it by very few loss.
[0029] 3-1 and 3-2 are branch line type hybrid circuits, and a RF signal is inputted from the slot coupling type hybrid circuit 12-1 or 12-4, respectively. Moreover, from the slot coupling type hybrid circuit 12-2 or 12-3, a RF signal is inputted through the delay line 4-1 or 4-2, respectively. One side constitutes a closed loop using the strip line or four pieces of microstrip lines of quadrant wavelength, and a branch line type hybrid circuit takes out an input/output terminal from each angle. A RF signal is effectively compounded by very few loss, or it is made to branch by this.
[0030] 11-1 to 11-4 is a micro-stripe array, and a RF signal is inputted through the electric supply line 9-1 to 9-4, respectively. the electric supply lines 8 and 8 of further plurality [signal / RF / this] -- each antenna elements 7 and 7 which were distributed to ... and connected to these -- it emanates from ... each electric supply lines 8 and 8 shown in this drawing -- if it is in ..., it branches to two electric supply lines 8 and 8, respectively from each electric supply line 9-1 to 9-4, and each of this electric supply line 8 has tournament composition which branches to two more electric supply lines 8 and 8
[0031] Each output terminal of the branch line type hybrid circuit 3-1 is connected to the electric supply line 9-2 or 9-4 through the delay line 6-1 and 6-2, respectively. Moreover, each output terminal of the branch line type hybrid circuit 3-2 is connected to the electric supply line 9-1 or 9-3 through a through hole 20-1 and 20-2, respectively. These through hole 20-1 and 20-2 have connected the 17th page of an upper surface substrate, and the

18th page of an inferior-surface-of-tongue substrate. Moreover, in the grand board 19, a slot 21-1 or 21-2 is formed in the through hole 20-1 and the portion corresponding to 20-2, respectively.

[0032] In this example, the RF signal first inputted from the electric supply terminal 2-1 to 2-4 of 4 port BATORA matrix feeder circuit is inputted into the slot coupling type hybrid circuit 12-1 to 12-4 which is the 1st hybrid circuit. The RF signal which the slot coupling type hybrid circuit 12-1 and 12-4 output is inputted into the branch line type hybrid circuit 3-1 which is the 2nd hybrid circuit, respectively, or 3-2. Moreover, the RF signal which the slot coupling type hybrid circuit 12-2 and 12-3 output is inputted into the branch line type hybrid circuit 3-1 or 3-2 after a phase is adjusted by the delay line 4-1 or 4-2, respectively.

[0033] As for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-1, a phase is adjusted by the delay line 6-1 or 6-2. then, it inputs into the each micro-stripe array 11-2 or 11-4 through the electric supply line 9-2 or 9-4, respectively -- having -- each antenna elements 7 and 7 -- it emanates from ... Moreover, the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2 is passed to the 18th page of an upper surface substrate by a through hole 20-1 or 20-2 from the 19th page of an inferior-surface-of-tongue substrate. then, it inputs into the micro-stripe array 11-1 or 11-3 through the electric supply line 9-1 or 9-3, respectively -- having -- each antenna elements 7 and 7 -- it emanates from ...

[0034] In this case, as for the RF signal inputted into the branch line type hybrid circuit 3-1 or 3-2, the phase needs to gather from each output terminal of the slot coupling type hybrid circuit 12-1 to 12-4. Then, the delay line 4-1 and the track length of 4-2 are beforehand determined so that each phase relation may become suitable. Similarly, also in the RF signal inputted into the micro-stripe array 11-1 to 11-4, the phase needs to gather from each output terminal of the branch line type hybrid circuit 3-1 or 3-2. Then, the delay line 6-1 and the track length of 6-2 are beforehand determined so that each phase relation may become suitable.

[0035] B. The 2nd example drawing 2 is the perspective diagram showing ****** of the 2nd example of this invention. Although the detail of the array antennas D using 4 port BATORA matrix feeder circuit shown in drawing 2 is explained hereafter, the same sign is given to each part explained by the 1st example and drawing 1 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0036] As for 7-1 and 7-2, an antenna element, 22-1, and 22-2 are through hole electric supply type antenna elements. The through hole 20-1 which connects the 17th page of an upper surface substrate and the 18th page of an inferior-surface-of-tongue substrate, respectively, or 20-2 is formed in the this through hole electric supply type antenna element 22-1 and end section side (left-hand side of drawing) of 22-2. Moreover, in the grand board 18, a slot 21-1 or 21-2 is formed in a through hole 20-1 and 20-2, and the corresponding position, respectively.

[0037] The antenna element 7-1 or 7-2 is connected to each output terminal of the branch line type hybrid circuit 3-1 through the delay line 6-1 or 6-2, respectively. Moreover, the through hole electric supply type antenna element 22-1 or 22-2 is connected to the delay line 6-3 connected to each output terminal of the branch line type hybrid circuit 3-2, or the edge of 6-4 through a through hole 20-1 or 20-2, respectively.

[0038] The RF signal outputted from each output terminal of the branch line type hybrid

circuit 3-1 is inputted and emitted to the antenna element 7-1 or 7-2, respectively, after a phase is adjusted by the delay line 6-1 or 6-2. Moreover, as for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-3 or 6-4. Then, 17th page ** of an upper surface substrate is passed by a through hole 20-1 or 20-2 from the 19th page of an inferior-surface-of-tongue substrate, and it inputs and emanates to the through hole electric supply type antenna element 22-1 or 22-2, respectively.

[0039] It is necessary to supply electric power to the antenna element 7-1, 7-2 or the through hole electric supply type antenna element 22-1, and 22-2 in the RF signal with which the phase gathered from the branch line type hybrid circuit 3-1 and 3-2. Then, each track length of the delay line 6-1 to 6-4 is beforehand determined so that each phase relation may become suitable.

[0040] C. The 3rd example drawing 3 is the perspective diagram showing ****** of the 3rd example of this invention. Although the detail of the array antennas E using 4 port BATORA matrix feeder circuit shown in drawing 3 is explained hereafter, the same sign is given to each part explained using the 1st and 2nd examples or drawing 1 , and drawing 2 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0041] 23-1 and 23-2 are through hole electric supply type micro-stripe arrays, and a RF signal is inputted through the electric supply line 9-1 or 9-3, respectively. the electric supply lines 8 and 8 of further plurality [signal / RF / this] -- it is distributed to ... each electric supply lines 8 and 8 shown in this drawing -- if it is in ..., it branches to two electric supply lines 8 and 8, respectively from each electric supply line 9-1 to 9-4, and each of this electric supply line 8 has tournament composition which branches to two more electric supply lines 8 and 8 moreover, each electric supply lines 8 and 8 -- the through holes 20 and 20 which connect the 17th page of an upper surface substrate, and the 18th page of an inferior-surface-of-tongue substrate to the point of ..., respectively ... is formed

[0042] the grand board 19 -- setting -- through holes 20 and 20 -- the portion corresponding to ... slots 21 and 21 ... is formed the 17th page of moreover, an upper surface substrate -- setting -- each through hole electric supply type antenna elements 22 and 22 -- the end section side (left-hand side) of ... through holes 20 and 20 ... is formed

[0043] As for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-3 or 6-4. then, it inputs into the through hole electric supply type micro-stripe array 23-1 or 23-2 by the electric supply line 9-1 or 9-3, respectively -- having -- each through hole electric supply type antenna elements 22 and 22 -- it emanates from ...

[0044] As for the branch line type hybrid circuit 3-1 and the micro-stripe array 11-1 from each output terminal of 3-2, 11-2 or the through hole electric supply type micro-stripe array 23-1, and the RF signal inputted into 23-2, the phase needs to gather. Then, each track length of the delay line 6-1 to 6-4 is beforehand determined that each phase relation will become suitable.

[0045] D. The 4th example drawing 4 is the perspective diagram showing ****** of the 4th example of this invention. Although the detail of the array antennas F using 4 port BATORA matrix feeder circuit shown in drawing 4 is explained hereafter, the same sign is given to each part explained by the 1st or 3rd example, drawing 1 , or drawing 3 , and a

corresponding portion, and the composition or detailed explanation of operation is omitted.

[0046] 25-1 and 25-2 are micro-stripe arrays. these -- the electric supply lines 24 and 24 for connection -- two or more antenna elements 7 and 7 which were connected one by one by ... and arranged by the single tier -- it consists of ... Moreover, these antenna elements 7 and 7 ... A RF signal is inputted into the antenna element 7 located in the end section inside. 26-1 and 26-2 are through hole electric supply type micro-stripe arrays. these -- the electric supply lines 24 and 24 for connection -- two or more antenna elements 7 and 7 which were connected one by one by ... and arranged by the single tier -- it consists of through hole electric supply type antenna elements 22 located in these ... and end section A RF signal is inputted into this through hole electric supply type antenna element 22 by the through hole 20-1 prepared in the end section (left end section), or 20-2.

[0047] Each output terminal of the branch line type hybrid circuit 3-1 is connected to the micro-stripe array 25-1 or the antenna element 7 of the end section of 25-2 through the delay line 6-1 and 6-2, respectively. Moreover, each output terminal of the branch line type hybrid circuit 3-2 is connected to a through hole 20-1 or 20-2 through the delay line 6-3 and 6-4, respectively.

[0048] As for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-1, a phase is adjusted by the delay line 6-1 or 6-2. then, it inputs into the micro-stripe array 25-1 or 25-2, respectively -- having -- each antenna elements 7 and 7 -- it emanates from ... Moreover, as for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-1 and 6-2. then, it inputs into the micro-stripe array 26-1 or 26-2 through a through hole 20-1 or 20-2, respectively -- having -- each through hole electric supply type antenna elements 22 and 22 ... or each antenna elements 7 and 7 -- it emanates from ...

[0049] As for the branch line type hybrid circuit 3-1 and the micro-stripe array 25-1 from each output terminal of 3-2, 25-2 or the micro-stripe array 26-1, and the RF signal inputted into 26-2, the phase needs to gather. Then, each track length of the delay line 6-1 to 6-4 is beforehand determined that each phase relation will become suitable.

[0050] E. The 5th example drawing 5 is the perspective diagram showing ****** of the 5th example of this invention. Although the detail of the array antennas G using 4 port BATORA matrix feeder circuit shown in drawing 5 is explained hereafter, the same sign is given to each part explained by the 1st or 4th example, drawing 1 , or drawing 4 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0051] 27-1 and 27-2 are the slot coupling type antenna elements formed in the 17th page of an upper surface substrate, respectively. The stub 29-1 for slot coupling or 29-2 is connected to each output terminal of the branch line type hybrid circuit 3-2 through the delay line 6-3 and 6-4, respectively. Moreover, in the grand board 19, a slot 28-1 or 28-2 is formed in the stub 29-1 for slot coupling, or the portion corresponding to 29-2, respectively. this -- the stub 29-1 for slot coupling, the slot coupling type antenna element 27-1, or the stub 29-2 for slot coupling and the slot coupling type antenna element 27-2 -- electromagnetism -- it has joined together-like

[0052] The RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2 is inputted into the stub 29-1 for slot coupling, or 29-2, respectively, after a

phase is adjusted by the delay line 6-3 and 6-4. and the stub 29-1 for slot coupling, or 29-2 and electromagnetism -- each which is combined-like -- it inputs and emanates to the slot coupling type antenna element 27-1 or 27-2

[0053] From the branch line type hybrid circuit 3-1 or 3-2, the RF signal with which the phase gathered needs to be supplied to the antenna element 7-1, 7-2 or the slot coupling type antenna element 27-1, and 27-2. Then, each track length of the delay line 6-1 to 6-4 is determined that each phase relation will become suitable.

[0054] F. The 6th example drawing 6 is the perspective diagram showing ****** of the 6th example of this invention. Although the detail of the array antennas H using 4 port BATORA matrix feeder circuit shown in drawing 6 is explained hereafter, the same sign is given to each part explained by the 1st or 5th example, drawing 1 , or drawing 5 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0055] two or more electric supply lines 8 and 8 to which 30-1 and 30-2 were slot coupling type micro-stripe arrays, the RF signal was inputted into by the electric supply line 9-1 or 9-3, and this RF signal was connected with tournament composition, respectively ... is supplied each electric supply lines 8 and 8 -- the point of ... the stubs 29 and 29 for slot coupling ... is formed

[0056] the grand board 19 -- setting -- the stubs 29 and 29 for slot coupling -- the portion corresponding to ... slots 28 and 28 ... is formed this -- the stubs 29 and 29 for slot coupling -- the slot coupling type antenna elements 27 and 27 by which ... was formed in the 17th page of an upper surface substrate ... and electromagnetism -- it has joined together-like

[0057] As for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-1 or 6-2. then, it inputs into the slot coupling type micro-stripe array 30-1 or 30-2 through the electric supply line 9-1 or 9-3, respectively -- having -- each slot coupling type antenna elements 27 and 27 -- it emanates from ...

[0058] As for the branch line type hybrid circuit 3-1 and the micro-stripe array 11-1 from each output terminal of 3-2, 11-2 or the slot coupling type micro-stripe array 30-1, and the RF signal inputted into 30-2, the phase needs to gather. Then, each track length of the delay line 6-1 to 6-4 is beforehand determined that each phase relation will become suitable.

[0059] G. The 7th example drawing 7 is the perspective diagram showing ****** of the 7th example of this invention. Although the detail of the array antennas I using 4 port BATORA matrix feeder circuit shown in drawing 7 is explained hereafter, the same sign is given to each part explained by the 1st or 6th example, drawing 1 , or drawing 6 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0060] 31-1 and 31-2 are slot coupling type micro-stripe arrays. these -- the electric supply lines 24 and 24 for connection -- two or more antenna elements 7 and 7 which were connected one by one by ... and arranged by the single tier -- it consists of through hole electric supply type antenna elements 27 located in these ... and end section

[0061] Each output terminal of the branch line type hybrid circuit 3-2 is connected to the stub 29-1 for slot coupling, or 29-2 through the delay line 6-3 and 6-4, respectively. In the grand board 19, a slot 28 or 28 is formed in the stub 29-1 for slot coupling, or the

portion corresponding to 29-2, respectively. each slot coupling type antenna elements 27 and 27 with which the stub 29-1 for slot coupling or 29-2 was formed in the 17th page of an upper surface substrate of this, and electromagnetism -- it has joined together-like

[0062] As for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-1 or 6-2. Then, it is inputted into the stub 29-1 for slot coupling, or 29-2, respectively. the stub 29-1 for slot coupling, or 29-2 -- each slots 28 and 28 -- minding -- each slot coupling type antenna elements 27 and 27 and electromagnetism -- since it has joined together-like, a RF signal is emitted from the slot coupling type micro-stripe array 31-1 and 31-2

[0063] As for the branch line type hybrid circuit 3-1 and the micro-stripe array 25-1 from each output terminal of 3-2, 25-2 or the micro-stripe array 26-1, and the RF signal inputted into 26-2, the phase needs to gather. Then, each track length of the delay line 6-1 to 6-4 is beforehand determined that each phase relation will become suitable.

[0064] H. Example drawing 8 of the octavus is the perspective diagram showing ****** of the example of the octavus of this invention. Although the detail of the array antennas J using 4 port BATORA matrix feeder circuit shown in drawing 8 is explained hereafter, the same sign is given to each part explained by the 1st or 7th example, drawing 1 , or drawing 7 , and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0065] The stub 32-1 for slot coupling or 32-2 is connected to each output terminal of the branch line type hybrid circuit 3-1 through the delay line 6-1 and 6-2, respectively. In the element substrate 33, the slot coupling type antenna element 27-1 or 27-2 is formed in the stub 32-1 for slot coupling or 32-2, and the corresponding position, respectively. therefore, the stub 32-1 for slot coupling, the slot coupling type antenna element 27-1, and the stub 32-2 for slot coupling and the slot coupling type antenna element 27-2 -- respectively -- electromagnetism -- it has joined together-like

[0066] Moreover, the through hole electric supply type antenna element 22-1 and 22-2 are formed in the element substrate 33. A through hole 20-1 or 20-2 is formed in the this through hole electric supply type antenna element 22-1 and end section side (left-hand side) of 22-2, respectively. A through hole 20-1 or 20-2 has connected the 33rd page of an element substrate, and the 18th page of an inferior-surface-of-tongue substrate. Moreover, in the grand board 19, a slot 21-1 or 21-2 is formed in the through hole 20-1 or the portion corresponding to 20-2. The through hole electric supply type antenna element 22-1 or 22-2 is connected to the delay line 6-3 connected to each output terminal of the line type hybrid circuit 3-2, and 6-4 through a through hole 20-1 or 20-2, respectively.

[0067] The RF signal outputted from each output terminal of the branch line type hybrid circuit 3-1 is inputted into the stub 32-1 for slot coupling, or 32-2, respectively, after a phase is adjusted by the delay line 6-1 and 6-2. and the stub 32-1 for slot coupling, or 32-2 and electromagnetism -- each which is combined-like -- it inputs and emanates to the slot coupling type antenna element 27-1 or 27-2 Moreover, as for the RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2, a phase is adjusted by the delay line 6-3 and 6-4. Then, the 33rd page of an element substrate is passed by a through hole 20-1 or 20-2 from the 19th page of an inferior-surface-of-tongue substrate, and it inputs and emanates to the through hole electric supply type antenna element 22-1 or 22-2, respectively.

[0068] The RF signal with which the phase gathered needs to be supplied to the antenna

element 7-1, 7-2 or the through hole electric supply type antenna element 22-1, and 22-2 from each output terminal of the branch line type hybrid circuit 3-1 and 3-2. Then, each track length of the delay line 6-1 to 6-4 is determined that each phase relation will become suitable.

[0069] I. The 9th example drawing 9 is the perspective diagram showing ****** of the 9th example of this invention. Although the detail of the array antennas K using 4 port BATORA matrix feeder circuit shown in drawing 9 is explained hereafter, the same sign is given to each part explained by the example, drawing 1 , or drawing 8 of the 1st or the octavus, and a corresponding portion, and the composition or detailed explanation of operation is omitted.

[0070] The stub 29-1 for slot coupling or 29-2 is connected to each output terminal of the branch line type hybrid circuit 3-2 through the delay line 6-3 and 6-4, respectively. On the other hand, in the element substrate 33, the slot coupling type antenna element 27-1 or 27-2 is formed in the stub 29-1 for slot coupling or 29-2, and the corresponding position, respectively. Moreover, in the grand board 19, a slot 28-1 or 28-2 is formed in the stub 29-1 for slot coupling, or the portion corresponding to 29-2, respectively. this -- the stub 29-1 for slot coupling, the slot coupling type antenna element 27-1, or the stub 29-2 for slot coupling and the slot coupling type antenna element 27-3 -- electromagnetism -- it has joined together-like

[0071] The RF signal outputted from each output terminal of the branch line type hybrid circuit 3-2 is inputted into the stub 29-1 for slot coupling, or 29-2, respectively, after a phase is adjusted by the delay line 6-3 and 6-4. and -- respectively -- the stub 29-1 for slot coupling, or 29-2 and electromagnetism -- each which is combined-like -- it inputs and emanates to the slot coupling type antenna element 27-1 or 27-3

[0072] The RF signal with which the phase was equal to the slot coupling type antenna element 27-1 to 27-4 needs to be supplied from each output terminal of the branch line type hybrid circuit 3-1 and 3-2. Then, each track length of the delay line 6-1 to 6-4 is determined that each phase relation will become suitable.

[0073] According to each above-mentioned example, the multi-beam antenna which emits a RF signal only above the upper surface substrate 17 can be constituted. Moreover, since the Butler matrix feeder circuit is divided and arranged two-layer [the 17th page of an upper surface substrate, and page / of an inferior-surface-of-tongue substrate / 19th], a circuit is miniaturized. Furthermore, electric supply lines 8 and 8 which will supply a RF signal to these if the number of antenna elements is increased ... A number also increases and the configuration becomes complicated. according to the 3rd example of this invention, or the 6th example -- these electric supply lines 8 and 8 -- it is dividing into two-layer [substrate / which corresponds ... / the 17th page of an upper surface substrate and the 19th page of an inferior-surface-of-tongue substrate] For this reason, it is possible for space to increase in number to the 17th page of an upper surface substrate, and to arrange many antenna elements. Moreover, according to the 4th example or the 7th example, since the antenna element of these plurality was arranged to the single tier by the electric supply line 24 for connection, the configuration of an electric supply line becomes easy and formation is easy.

[0074] In addition, in each above-mentioned example, although the array antennas using 4 port BATORA matrix feeder circuit were mentioned as the example and explained, if this inventions are the array antennas using the feeder circuit in which intersection of a

line exists, they can apply all. moreover, the electric supply lines 8 and 8 -- the composition of ... is not what was limited to tournament composition
[0075]
[Effect of the Invention] In the array antennas which are constituted by the front face of the 1st which sandwiches a grand board, and 2nd dielectric boards by the microstrip line according to this invention as explained above the 2nd network which forms in the front face of the 1st dielectric the 1st network which constitutes the Butler matrix feeder circuit, and constitutes the Butler matrix feeder circuit -- the front face of the 2nd dielectric board -- forming -- between the 1st network and the 2nd network -- the 1st coupling means -- electromagnetism -- it is made to join together-like Moreover, the 1st radiation means and the 2nd radiation means are formed in a 1st dielectric side, a RF signal is supplied to the 1st radiation means from the 1st network, and a RF signal is supplied to the 2nd radiation means from the 2nd network. Since a RF signal is supplied to the this 1st network to 1st radiation means, and the 2nd network to 2nd radiation means by the microstrip line, the 2nd, or 3rd coupling means, wiring by the air bridge or the semi rigid cable can be arranged to ******, and two or more antenna elements can be arranged to the same field. For this reason, the flexibility at the time of arranging an antenna element is high, and since manufacture is easy, the effect that cost can realize the electric supply method to low array antennas and array antennas is acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective diagram showing the composition of the 1st example of this invention.
[Drawing 2] It is the perspective diagram showing the composition of the 2nd example of this invention.
[Drawing 3] It is the perspective diagram showing the composition of the 3rd example of this invention.
[Drawing 4] It is the perspective diagram showing the composition of the 4th example of this invention.
[Drawing 5] It is the perspective diagram showing the composition of the 5th example of this invention.
[Drawing 6] It is the perspective diagram showing the composition of the 6th example of this invention.
[Drawing 7] It is the perspective diagram showing the composition of the 7th example of this invention.
[Drawing 8] It is the perspective diagram showing the composition of the example of the octavus of this invention.
[Drawing 9] It is the perspective diagram showing the composition of the 9th example of this invention.
[Drawing 10] It is the perspective diagram showing the composition of the conventional Butler matrix circuit electric supply type array antennas.
[Drawing 11] It is the perspective diagram showing the composition of the conventional Butler matrix circuit electric supply type antenna.
[Description of Notations]
3-1, 3-2 Branch line type hybrid circuit
4-1, 4-2, 6-1 to 6-4 Delay line
7, 7-1, 7-2 Antenna element
8 Electric Supply Line
9-1 to 9-4 Electric supply line
12-1 to 12-4 Slot coupling type hybrid circuit
13-1, 13-2 Slot
17 Upper Surface Substrate
18 Grand Board
19 Inferior-Surface-of-Tongue Substrate
20, 20-1, 20-2 Through hole
21, 21-1, 21-2 Slot

22, 22-1, 22-2 Through hole electric supply type antenna element
24 Electric Supply Line for Connection
27, 27-1, 27-2 Slot electric supply type antenna element
28, 28-1, 28-2 Slot
29, 29-1, 29-2, 32-1, 32-2 Stub for slot coupling

* NOTICES *

Japan Patent Office is not responsible for any damag s caused by the use of this translation.

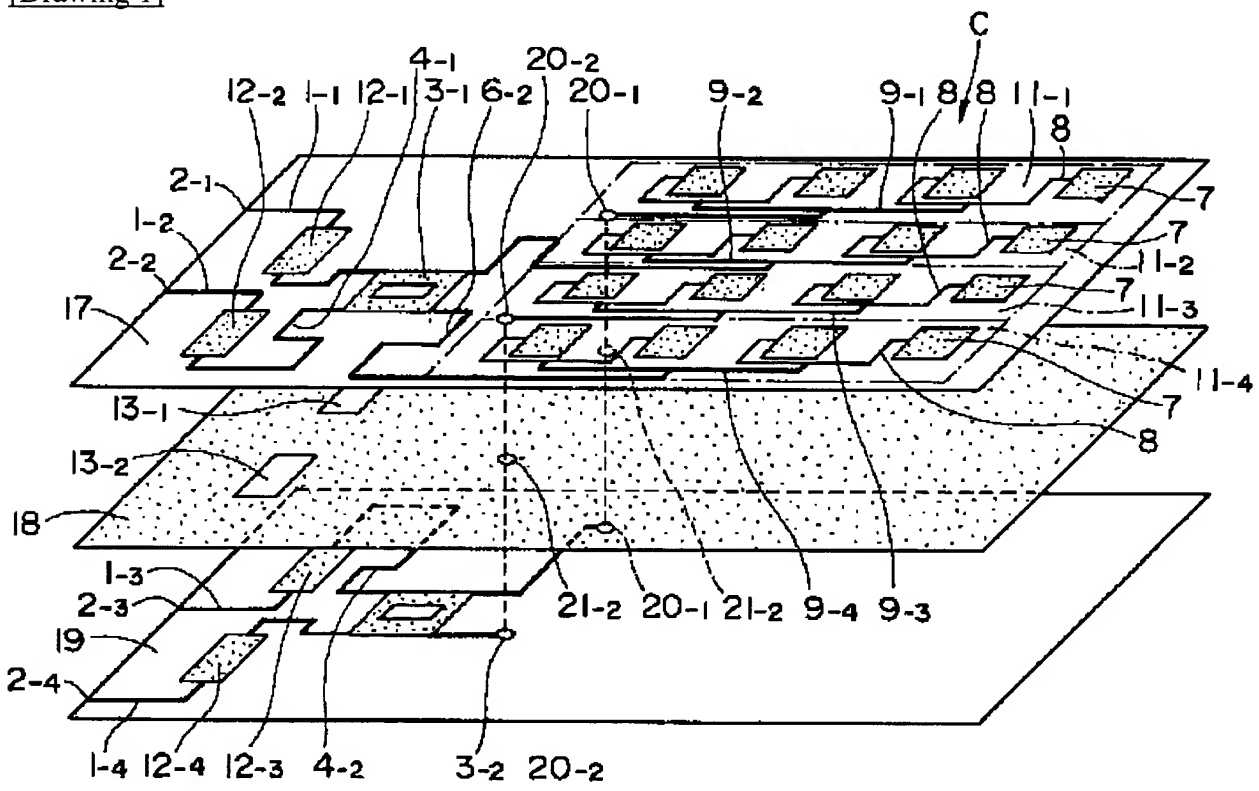
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

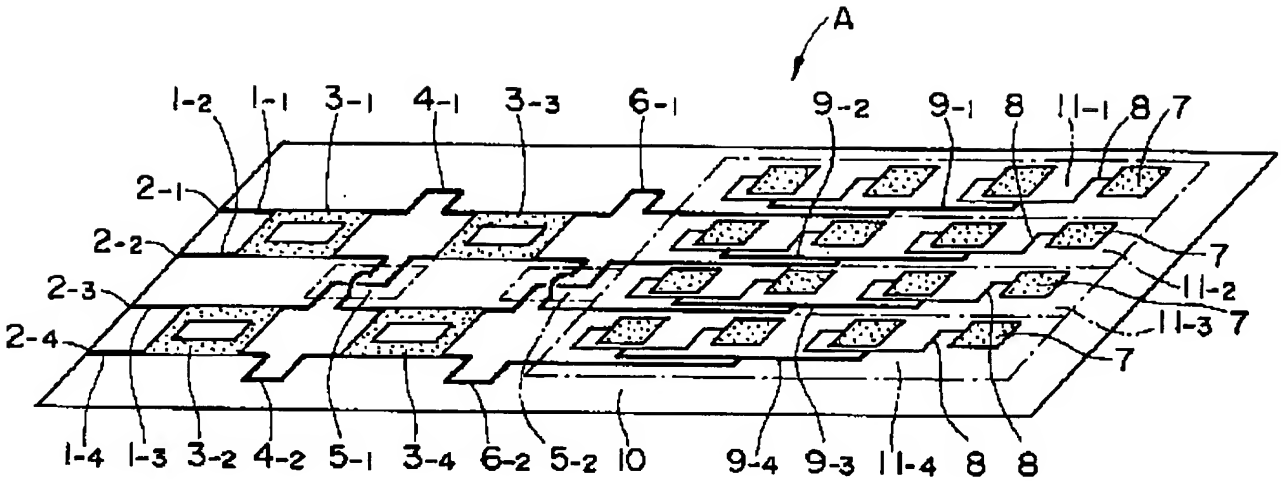
3.In the drawings, any words are not translated.

DRAWINGS

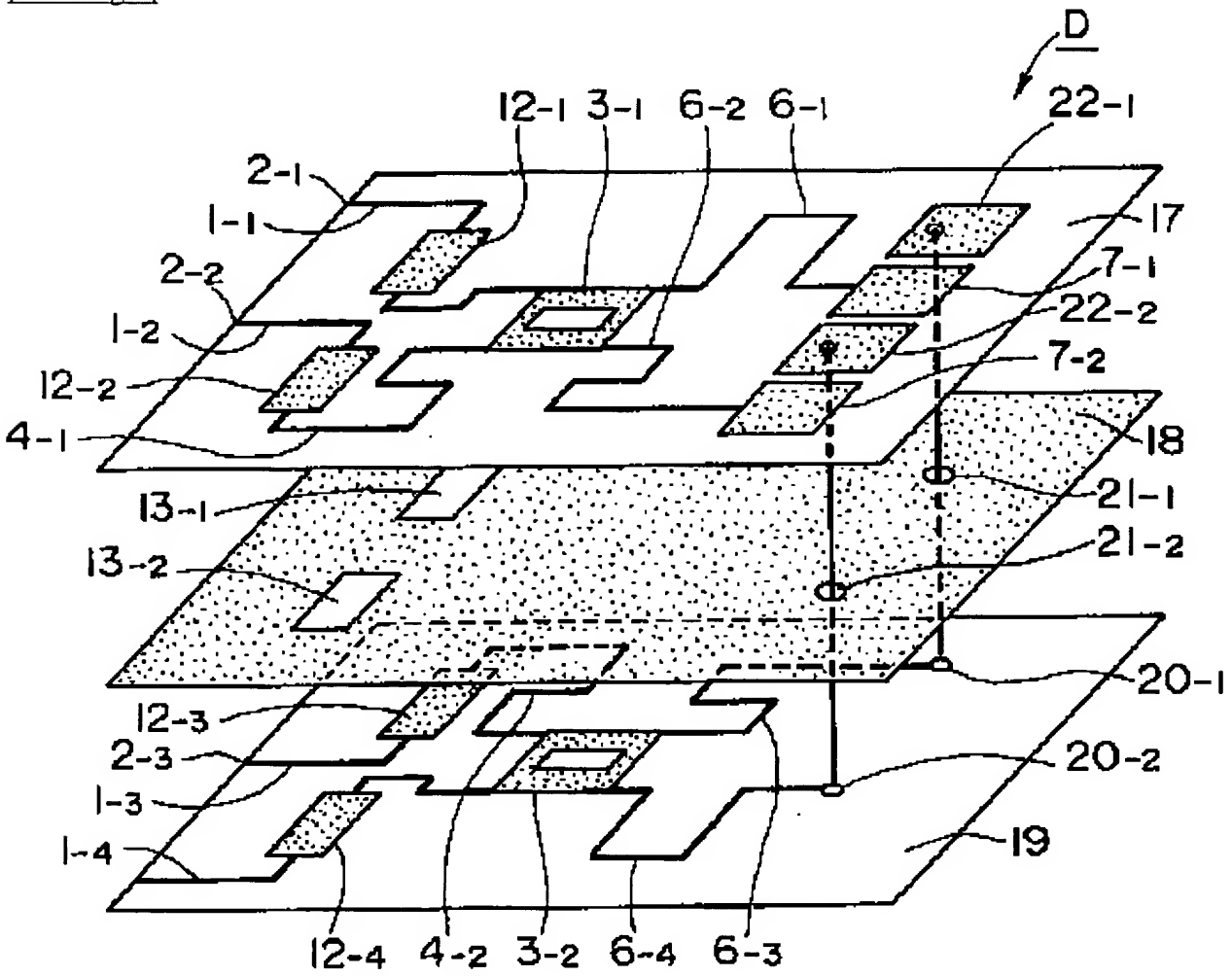
[Drawing 1]



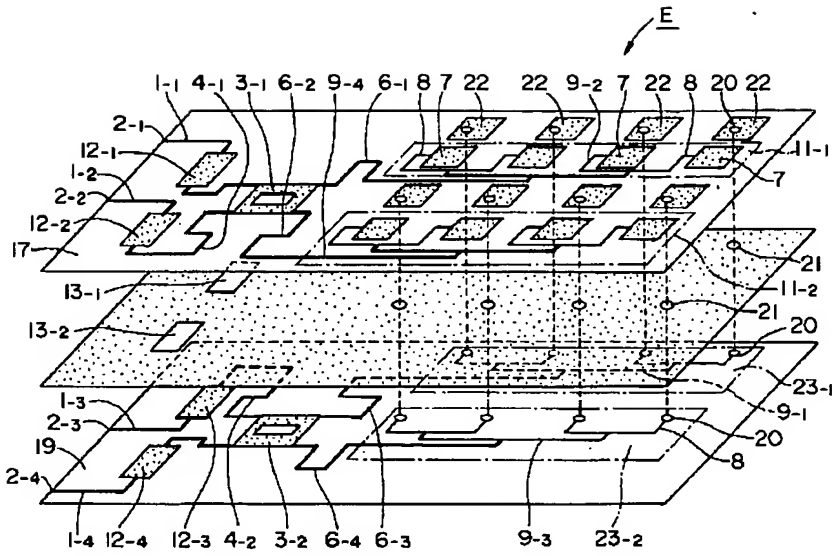
[Drawing 10]



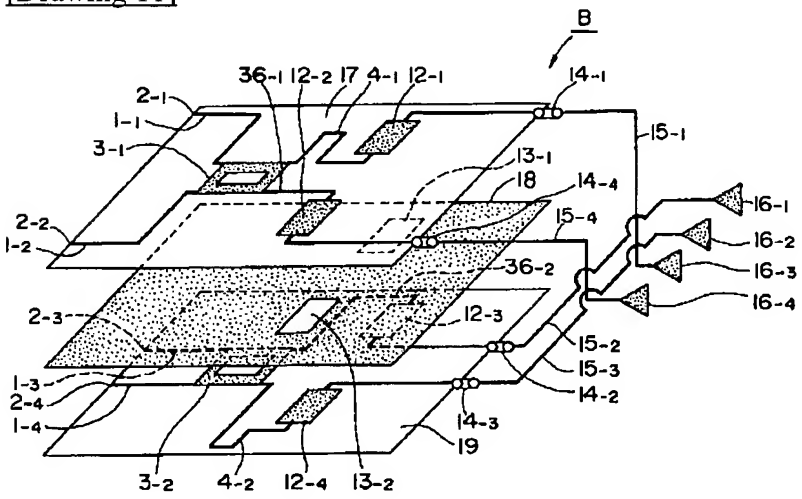
[Drawing 2]



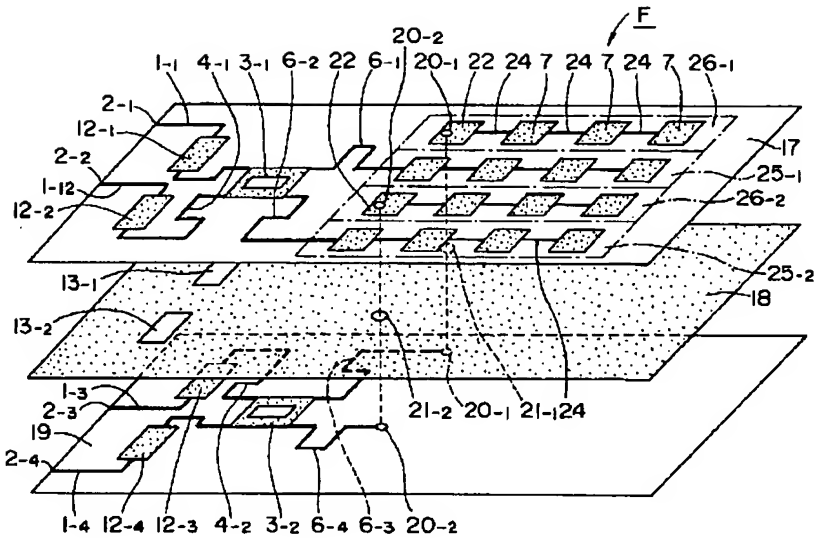
[Drawing 3]



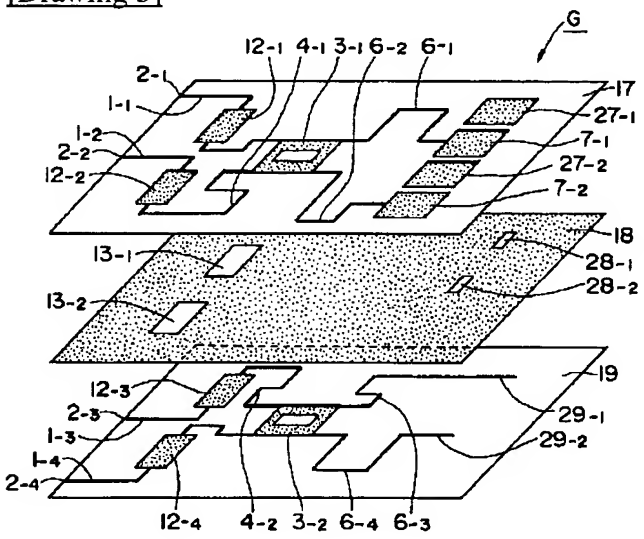
[Drawing 11]



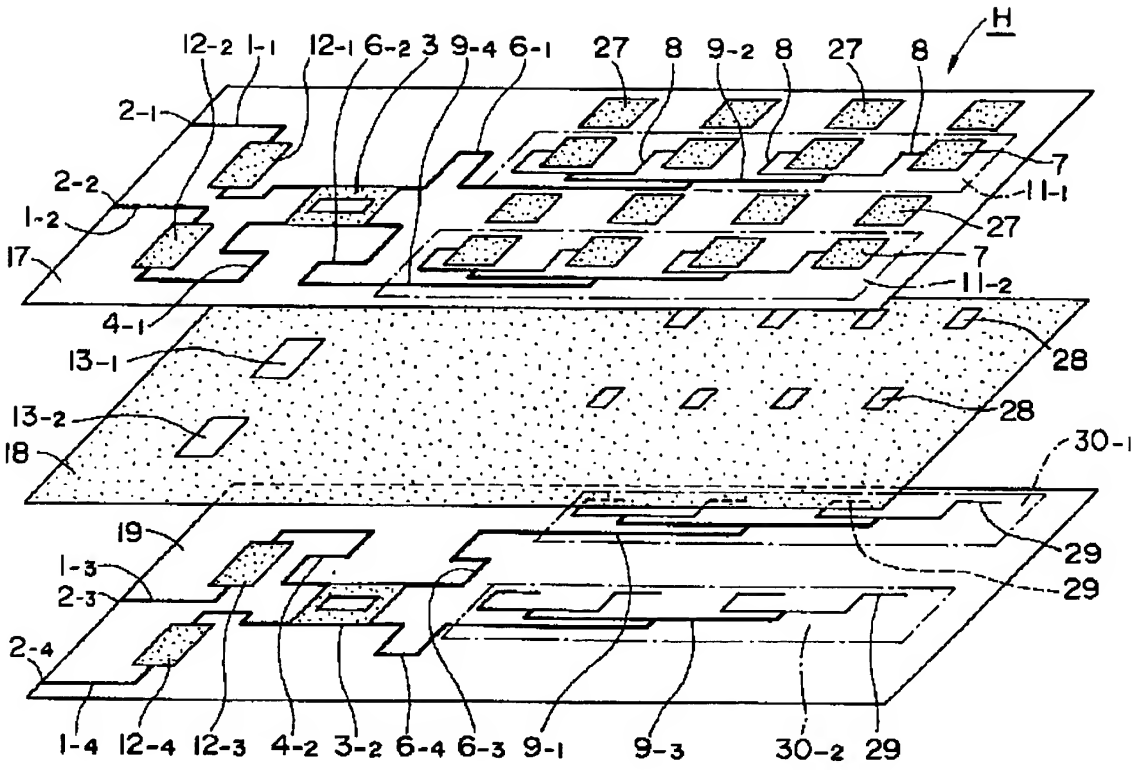
[Drawing 4]



[Drawing 5]



[Drawing 6]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2-2
1-2
17
4-1
13-1
13-2
18
19
1-3
2-3
2-4
7
11-1
27
7
11-2
28
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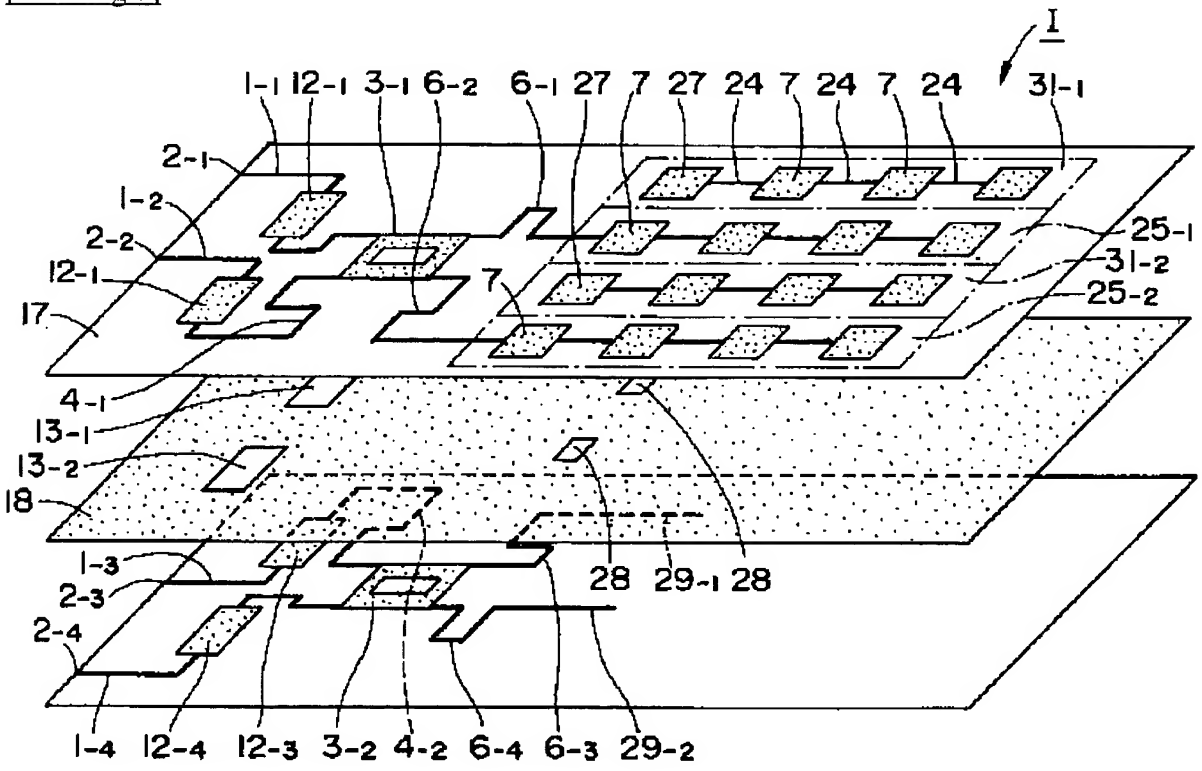
[Drawing 7]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1-2
2-2
12-1
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4-1
13-1
13-2
18
1-3
2-3
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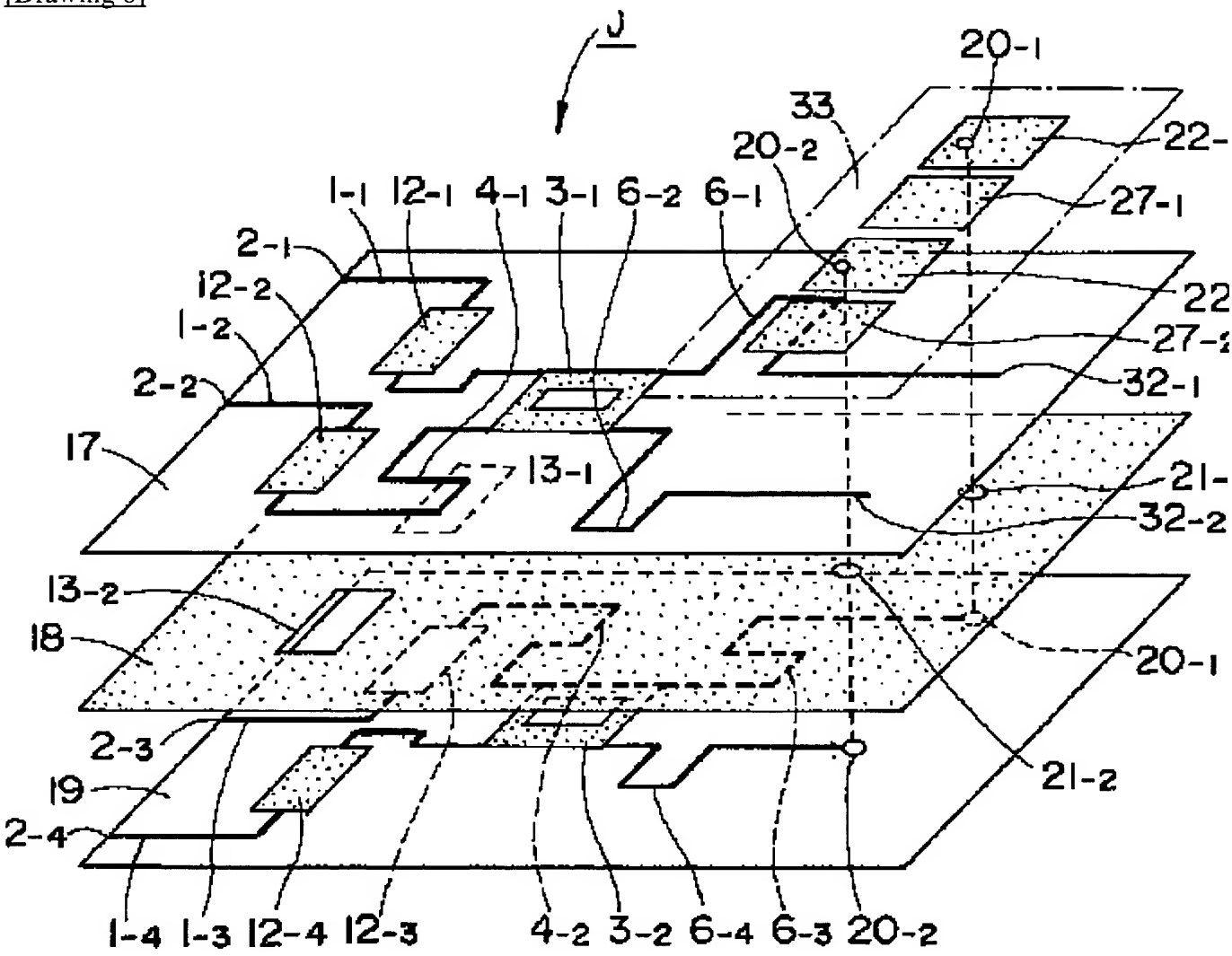
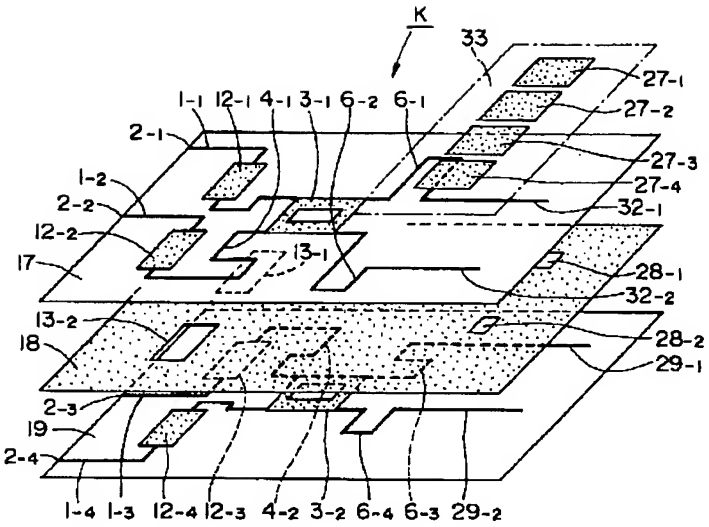
[Drawing 8]



[Drawing 9]



[Translation done.]